Boulder Creek Restoration Project

Hydrology Report

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for:
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Introduction

Proposed activities for the Boulder Creek Restoration Project (BCRP) include timber harvest, post-harvest fuels treatment (controlled burning and piling), regeneration planting, landscape burning, and road system modifications (temporary road construction, existing road reconstruction, road maintenance, and road storage), including replacing culverts that are barriers to aquatic organisms. This project also proposes to restore beavers to a portion of Boulder Creek through a partnership with Idaho Department Fish and Game. The focus of this report is to document existing conditions of hydrologic resources and associated aquatic habitat in the project area and to analyze potential environmental effects of the proposed activities. A description of the project area, purpose and need, and proposed project alternatives can be found in the BCRP Environmental Analysis (EA).

Relevant Laws, Regulations, and Policy

Regulatory Framework

Land and Resource Management Plan

The Idaho Panhandle National Forests Land and Resource Management Plan (the Forest Plan) guides all natural resource management activities and establishes management direction for the Idaho Panhandle National Forests. The 2015 Forest Plan includes direction for the maintenance and improvement of water quality and aquatic habitats. The Inland Native Fish Strategy (INFS) amended the Forest Plan direction regarding stream and fish habitat protection measures and was updated in the 2015 Forest Plan to include the restoration emphasis that was lacking in INFS and also clarified INFS direction as either standards or guidelines. Plan components that may be applicable to the watershed, soils, riparian, aquatic habitat, and aquatic species resources are found on pages 22-29 of the plan.

Federal Law

Clean Water Act

The Clean Water Act requires the states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. Stipulations in the Clean Water Act require the Environmental Protection Agency (EPA) and the States to develop plans and objectives that will eventually restore identified stream segments of concern. The Clean Water Act (CWA) requires all water bodies that are deemed to be not fully supporting their beneficial uses by the state (Idaho and Washington) be brought onto the 303(d) list as water quality limited. For waters identified on this list, states must develop a Total Maximum Daily Load (TMDL) for the pollutants set at a level to achieve water quality standards.

National Forest Management Act

Section 6 of NFMA provides language to "insure that timber will be harvested from National Forest System lands only where; soil, slope, or other watershed conditions will not be irreversibly damaged; protection is provided for streams, stream-banks, shorelines, lakes, wetlands, and other bodies of water from detrimental changes in water temperatures, blockages of water courses, and deposits of sediment, where harvests are likely to seriously and adversely affect water conditions or fish habitat; and that such [harvests] are carried out in a manner consistent with the protection of soil, watershed, and fish, resources.

Executive Orders

Protection of Floodplains, Executive Order 11988

Requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative.

Protection of Wetlands, Executive Order 11990

Directs federal agencies to provide leadership and shall take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities for conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing activities.

State and Local Law

Idaho Forest Practices Act

The Idaho Forest Practices Act regulates forest management on all ownerships in Idaho, including National Forest System lands (Title 38, Chapter 13, Idaho Code 2000).The Forest Service has agreements with the state to implement best management practices (BMPs) for all management activities. All activities would meet or exceed guidelines described in the Soil and Water Conservation Handbook (Forest Service Manual 2509.22)

Idaho Stream Channel Protection Act

The Idaho Stream Channel Protection Act requires that the stream channels of the state and their environment be protected against alteration for the protection of fish and wildlife habitat, aquatic life, recreation, aesthetic beauty and water quality. The Stream Channel Protection Act requires a stream channel alteration permit from Idaho Department of Water Resources before any work that would alter the stream channel may begin.

Topics and Issues Addressed in This Analysis

Resource Indicators and Measures

Table 1. Resource indicators and measures for assessing effects to hydrology.

Resource Element	Resource Indicator	Measure (Quantify if possible)
Water Quality	Sediment Delivery	Amount of sediment delivery to project streams (tons/year)
	Temperature	Riparian vegetation preserved or improved (acres)
Watershed Function	Road Density	Miles of road per square mile **(mi/ mi^2)**
	Equivalent Clearcut Area	Acres

Water Quality

Sediment Delivery

Sediment yield to streams is a natural process and includes events such as landslides and wildfires. These events can deliver tremendous amounts of sediment but are stochastic in nature and occur infrequently over time. (Moody and Martin 2009) reviewed post-wildfire literature and found mean sediment delivery amounts from hillslopes of 82 tons/ha with even larger yields from channels. Aquatic ecosystems on the forest have evolved within the context of these kinds of stochastic events, e.g. the wildland fire of 1910.

Random sediment inputs to stream channels occur as a complex series of pulses that are delivered and stored within low order, high gradient stream channels (Benda and Dunne 1997). Sediment accumulates for centuries within these channels before being transported or "flushed" downstream by episodic events with large increases in water yield (Kirchner et al. 2001). Transport of sediment plays a fundamental role in the natural function of forested watersheds. In excess, suspended sediment degrades aquatic and fish habitat, disrupts hyporheic connection, enhances the transport of sorbed pollutants, and increases treatment costs associated with municipal water withdrawal (Rehg et. al. 2005).

Forests generally have very low erosion rates unless they are disturbed (Elliot et. al. 2000). Common disturbances include timber harvest operations, roads, prescribed burning, and wildfires. Impacts to soil erosion from these activities last a few years before rapid revegetation covers the surface with protective plant litter (Elliot 2004). However, not all impacts to soil erosion are short lived. Numerous research studies have documented that forest roads are usually the leading contributor of sediment to stream channels (Duncan et al. 1987, Bilby et al. 1989, Gucinski et al. 2001).

Forest roads can be chronic sources of sediment because; road construction, use, and maintenance compact soils, reduce infiltration, intercept and concentrate surface and subsurface runoff, and limit growth of vegetation. Road ditches can be a direct conduit of sediment from ditch and road erosion into live water bodies. Also, roads can increase the frequency and magnitude of mass wasting (i.e. landslides) by one of several ways:

- Improper alignment can undercut the base of unstable slopes.
- Roads can intercept, divert, and concentrate runoff to sections of the hillside that are unaccustomed to overland flow causing soil saturation and slope failures.
- Culverts and other drainage structures can become plugged with debris and the subsequent flow over the road surface can cause failures.

If roads are located on sensitive landtypes, the probability of failure is increased. All of these characteristics can lead to a negative effect on aquatic resources.

While some amount of sediment delivery may not be inherently detrimental to aquatic resources, sources of sediment from anthropogenic activities can be controlled and should be addressed where necessary. The most common source of sediment in the project area, resulting from anthropogenic activities, is from roads. Sediment from roads tends to be of a size which has more ecologically damaging properties. While sediment contributions from roads may be relatively minor component compared to landscape scale sediment regimes, roads are areas where sediment delivery effects from management activities can be reduced.

Water Temperature

Water temperature has a profound effect on organisms that live or reproduce in the water, particularly Idaho's native coldwater fish such as westslope cutthroat trout and some amphibians (frogs and salamanders). When water temperature becomes too warm, trout suffer a variety of ill effects ranging from decreased spawning success to death. Most streams naturally warm as they flow from their headwaters to their mouth. Human-caused warming acts to shrink the available habitat that is suitable for coldwater-dependent species.

Elevated stream temperatures can result from both natural and human-caused events. Land management (human activity) can increase stream temperatures by removing vegetation along streambanks, which reduces the amount of shade over the water thereby increasing the amount of solar radiation reaching the stream. Stream temperature can also be elevated by excessive sedimentation (i.e., build-up of boulders, rocks, gravel, sand, dirt, and silt), which results in a stream becoming wider and shallower, making it harder to shade and easier to heat. Sediment is a natural part of a stream system, but land management activities like road building, agriculture, forestry, and urban development can increase the amount of sediment entering a stream, delivering higher amounts of sediment than the stream can handle.

The water temperature TMDL for Boulder Creek indicates that preserving or improving riparian shade and restoring natural channel widths are recommended as the primary activities for implementation of the temperature TMDL. Generally speaking, the areas that have altered riparian shade and modified channel widths are those whose floodplains have been disturbed by road building activities. Floodplains also provide streams numerous other benefits including the ability to dissipate energy during high flow events. If a stream cannot access a floodplain, the increased volume of water would cause increased rates of erosion and deposition. Erosion of streambanks could remove vegetation, which provides shade, thus potentially negatively affecting water temperature. Deposition of newly eroded material could lead to wide channel conditions, creating temperature increases due to wide, shallow channels.

The surrogate measure for water temperature is area of riparian vegetation preserved or improved is used because direct incoming solar radiation is the dominant energy input for increasing stream temperatures with shade being the single most important variable to reduce this heat input (Cobb 1988, Gravelle and Link 2007, Krauskopf et.al. 2010).

Watershed Function

Road Density

Road densities can provide a relative measure of road-stream interaction and the relative risk for increased flows and sediment input into the hydrologic system. Road density is sometimes used as a proxy for impacts to streams and watersheds and has been shown to generally reduce fisheries composition and persistence with higher densities. A review of research in Idaho and elsewhere concluded that non-channelized runoff from roads has a low probability of traveling further than 300 feet (Belt. et al. 1992). Road densities located with 300 feet of streams, or the hydrologic road density are at greater risk for flow modification and sediment loading. The number of road miles is calculated from GIS information and includes all roads on the system, whether open for public motorized use or for administrative use only. Decommissioned or previously stored roads were not included in the density calculations because they have been treated to reduce impacts to hydrology (i.e. ditches drained frequently by waterbars, culverts removed, etc).

Equivalent Clearcut Area

There are many past events (i.e. wildfires) and silviculture activities within the watersheds that impact water resources. Equivalent clearcut area (ECA) modeling can be performed to assess the level of impacts from past and proposed harvest activities. Such an analysis is a tool used to assess potential increases in areas of canopy removal from past and proposed activities such as clearcuts, partial cuts, road building and decommissioning, and burned areas within the project watersheds. ECA, when above a certain threshold (discussed in the methodology section) can also be related to changes to water yield and peak flows.

Methodology

The objective of this analysis is to disclose the potential effects of the project activities on watershed resources. Changes to sediment delivery, stream temperatures, and watershed function were used to evaluate potential effects on watershed resources.

The analysis begins with a description of the affected environment that characterizes the drainages within the project area and the aquatic resources found there. The affected environment section establishes a reference condition, providing insight into historical patterns and processes, and providing a basis for predicting the effects of natural and human disturbances. This section includes establishment of the existing condition where effects of past activities and natural events that have influenced the aquatic resources can provide a baseline against which effects can be evaluated.

The environmental consequences section begins by examining the potential direct and indirect effects of proposed activities on watershed resources through analysis of changes in water quality and watershed function. This section includes an evaluation of potential cumulative effects. The cumulative effects analysis combines direct and indirect effects with effects of past, present, and reasonably foreseeable activities throughout the Boulder Creek watershed.

Information Sources

Literature and Office Review

Background and supporting information for this report was gathered from Forest Service fish and hydrology files, geographic information system (GIS) data, historical records, aerial photographs, and published and unpublished scientific literature. Research for this project included discussions with the Idaho Department of Environmental Quality. Also, a transportation analysis process (TAPS) was completed in 2015 that provided recommendations for long-term road management objectives within the project area.

FS WEPP – Forest Service Water Erosion Prediction Project

Several FS WEPP online interface tools were used as a means to predict and compare sediment delivery from physical disturbances such as wildfire, road construction and maintenance, timber harvesting, and prescribed burning. These models and supporting documentation can be found at: http://forest.moscowfsl.wsu.edu/fswepp/. The WEPP model is a physically based soil erosion model that provides estimates of soil erosion and sediment yield considering site-specific information about soil texture, climate, ground cover, and topographic settings (Elliot et al. 2000).

FS WEPP:Road is a set of interfaces designed to allow users to quickly evaluate erosion and sediment delivery potential specifically from forest roads. The erosion rates and sediment delivery are predicted by the WEPP model, using input values for forest conditions developed by scientists at the Rocky Mountain Research Station (Elliot et. al. 1999). FS WEPP:Road was used to estimate erosion and sediment yield from selected road segments within the project area. WEPP:Road values reflect road dimensions, design, topography, and proximity to water bodies among other parameters; output is in average annual amount of sediment delivered to streams.

Erosion research conducted in north Idaho by Spinelli et al. (2008) found favorable correlation to measured values using FS WEPP:Road. The accuracy of the predicted values from FS WEPP tools are, at best within plus or minus fifty percent. True erosion rates are highly variable due to large variations in local topography, climate, soil properties, and vegetative properties, so predicted values are only a single estimate of a highly variable process (Elliot et al. 1999).

Equivalent Clearcut Area

The ECA calculator was used to depict changes and fluctuations in water yield conditions over time. The ECA method followed the procedures in the USFS Flathead National Forest ECA User Guide (USDA 2012). ECA estimates water yield likely to be delivered to the main channel of a study watershed as modified by forest management and practices within the watershed, including the headwater stream channels. Forest management practices considered are timber harvest, road building, and fires. These estimates include a series of anticipated annual values over a period of years as recovery occurs. The ECA analysis for this project was run as if all project activities would be implemented in 2019. However, it is far more likely that implementation would be spread out over as much as a 10 year period, so the ECA values generated represent a worst case scenario. Some of the key assumptions and limitations of the method are listed below.

- Results do not reflect above average or below average precipitation and associated yield.
- Potential changes in the timing and duration of stream discharge are not predicted.
- The method estimates water yield increases assuming a fully forested condition prior to disturbance across the watershed of interest, which is not realistic due to natural processes such as fire, insects, and disease.
- The shape, size, and aspect of forest disturbances have major influences on snow interception, accumulation, redistribution, and melt. These processes are not captured in the ECA method.
- The method does not account for natural openings such as talus slopes or meadows.
- Hydrologic recovery curves are purely theoretical and they do not account for site specific stand conditions, particularly regeneration.

- Runoff processes are highly complex and the ECA method does not discriminate between saturation overland flow (variable source), infiltration excess overland flow, soil depth, or soil moisture.

The ECA method addresses average conditions and does not consider extreme or rare events, such as high intensity rain storms or rain-on-snow events. Nor does it take into account how the baseline hydrology may have changed due to changes in forest structure and health over the last century. It is a very simple water balance calculator, and relies on average annual precipitation and forest cover to estimate average annual water yield in the form of stream flow. The ECA method is not designed, nor is it used, to develop precise estimates of flow. One utility of the method is that it provides a consistent way to compare alternatives. The values generated by the method may be used, in concert with other water resource information, to interpret the potential effects to stream channels as a result of implementing management activities. Values generated by the method are not to be considered absolute measures against verifiable standards, nor by themselves provide an answer as to the effects of implementing the proposed land management activity. Therefore, the use of models is to provide one set of information to the technical user, who, along with knowledge of the model and its limitations, other models, data, analysis, experience and judgment must integrate all those sources to make the appropriate findings and conclusions.

Field Reviews

Selected roads, streams, and proposed units within the project area were surveyed from the 2013 through 2016 field seasons by the project hydrologist and trained hydrologic technicians. Roads were surveyed to assess erosional hazards and risks to aquatic ecosystems and were prioritized where roads were in close proximity to streams. Road surveys included examination of stream crossings and drainage structures. All survey information can be found in the hydrology section of the project record.

There were also several field trips with our local collaborative group where aquatics related issues, such as beaver reintroduction, aquatic organism passage and road stream interactions were reviewed and discussed which added to the project hydrologist’s knowledge of the area.

Incomplete and Unavailable Information

All analysis and modeling is based upon best available data. At this point in time there is no known incomplete or unavailable information. If new information should become available, it would be stated and incorporated into the analysis.

Spatial and Temporal Context for Effects Analysis

Direct/Indirect and Cumulative Effects Boundaries

Direct and indirect effects will be analyzed at the Boulder Creek watershed scale because that is where all the proposed ground-disturbing activities would occur. The entire Boulder Creek watershed is composed of two 6th code hydrologic units, Upper Boulder Creek and Lower Boulder Creek. The Upper Boulder hydrologic unit is 22,301 acres and includes the headwaters streams and Middle Fork Boulder Creek. The Lower Boulder hydrologic unit encompasses 18,276 acres and includes the lower reaches of Boulder Creek and tributaries including East Fork Boulder Creek and North Creek. The temporal boundaries for analyzing the direct and indirect effects are approximately 5 years from present to allow all project related activities such as timber harvest, road work, and tree planting to occur. This timeframe was selected because the probability of erosion decreases several years after disturbance as vegetation recovers (Elliot et al. 2004)

Cumulative Effects Boundaries

Cumulative effects will also be examined at the Boulder Creek watershed scale. Cumulative effects will be analyzed at this level in order to incorporate other disturbances that may have occurred or are occurring elsewhere in the watershed. Analyzing at the next highest stream level (the Kootenai River) would be too large to detect project related effects. Cumulative effects will be considered from present to approximately 2045, which would allow sufficient time for vegetation to recover in terms of hydrologic processes.

Affected Environment

The Boulder Creek watershed (the project area) encompasses approximately 40,600 acres in Boundary County, Idaho and is about 11 miles southeast of the city of Bonners Ferry, Idaho (see Figure 1). The Boulder Creek confluence with the Kootenai River is located about ½ mile west of the Idaho/Montana state line. The entire project area is administered by the USDA Forest Service, except for about 50 acres of private lands.

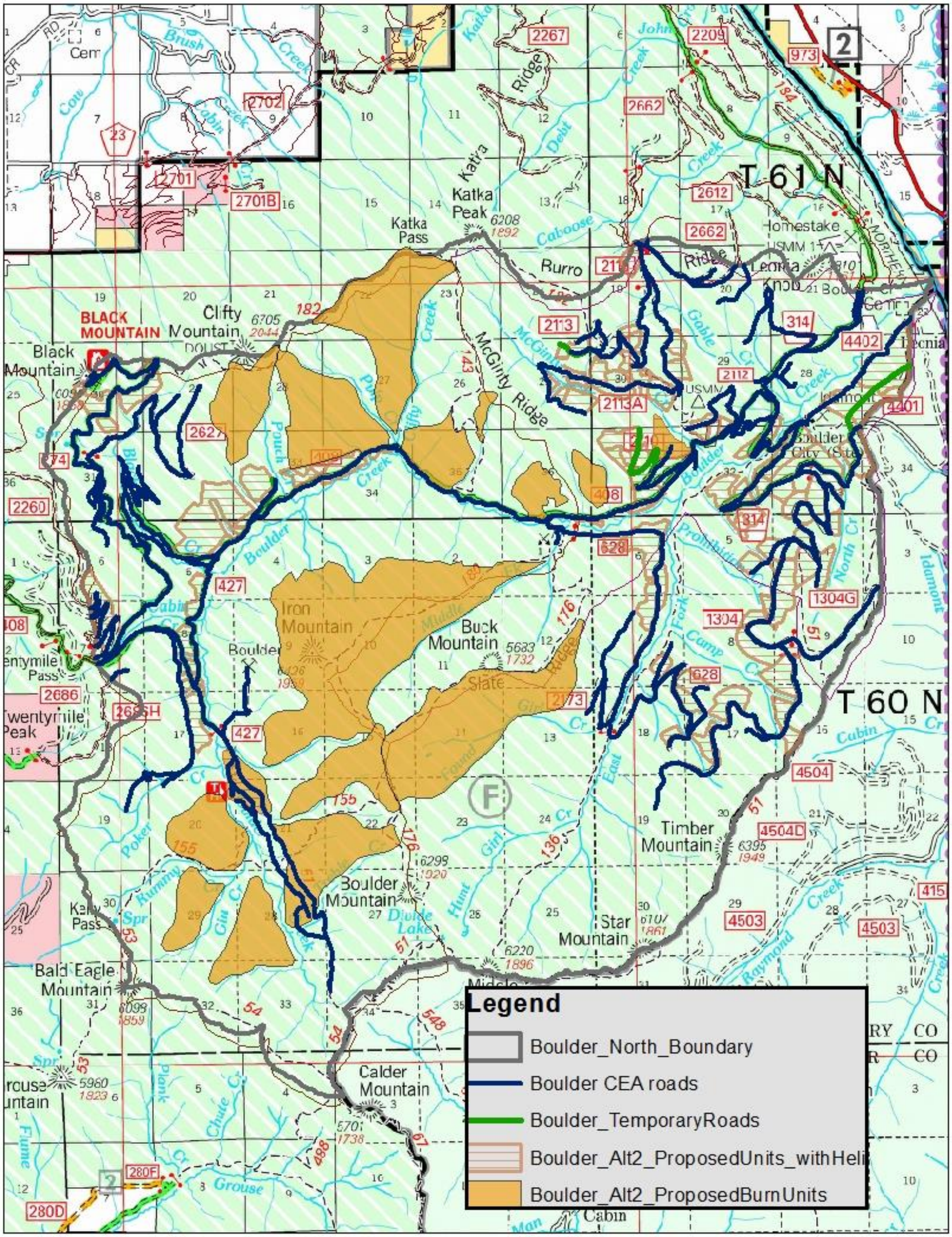

Figure 1. Boulder Creek Restoration Project area map.

Topography and Climate

Elevations within the project area range from a low of 1800 feet at the confluence with the Kootenai River to about 6700 feet at Clifty Mountain in the headwaters. Aspects are variable, but the area drains generally to the northeast as seen in Figure 1. Slopes range from about 4 to over 75 percent in the project area.

Records from the nearest weather station in Bonners Ferry, ID (located about 11 miles northwest of the project area) indicates January as the coldest month with average high temperature of 32.3°F and average low of 19°F. July is the warmest month with average high and low temperatures of 83.7°F and 50.1°F respectively. Average annual precipitation is 22.1 inches. The wettest month, on average is December with 3.09 inches and the driest month is August with 0.9 inches of precipitation. Average annual snowfall for Bonners Ferry is 65.4 inches with the most falling in December and January (Western Regional Climate Center 2017).

The climate data described above was collected at an elevation of 1850 feet, which is significantly lower than the project area. PRISM, a precipitation model within the US Forest Service WEPP models adjust precipitation and temperatures based on elevations and topography from established weather station data. The model allows users to input latitude and longitude and the model adjusts the climate for that location. A location near the center of the project area (48.56º N x 116.14ºE) was selected and input into PRISM which returned results of 4510 feet elevation with an annual average precipitation of approximately 43”. These estimates shows how elevation can influence precipitation within the project area. These climate values were used in the WEPP model to estimate erosion rates from the proposed treatment areas. More specifics on climate parameters generated by PRISM can be found in the Hydrology section of the project file.

Soils and Geology

The project area has bedrock geology comprised mostly of Precambrian Belt Supergroup formations, with a minor component of intrusive granitics. This portion of the basin contains significant amounts of glacial outwash and till deposits on the mid-slopes and valley bottoms. The soils in the project area are derived from belt rock tills overlain with volcanic ash and can be described as having silt loam to sandy loam textures. These soils are very productive and tend to be less erodible than soils derived from granite.

Wetlands

Several wetlands were identified within the project area from searching the National Wetlands Inventory (http://www.fws.gov/wetlands/). Most are located along the Boulder Creek Stream Channel, such as in the Boulder Meadows area. These and all other wetlands that may be located during field reviews or project implementation would receive appropriate protections as described in the project design features.

Beneficial Uses and Water Quality Status

Water quality refers to the physical, chemical, and biological composition of a given water body and how these components affect beneficial uses. The Clean Water Act requires beneficial uses to be protected for each water body in the state. The designated beneficial uses for Boulder Creek are cold water aquatic life, primary contact recreation, and salmonid spawning. In addition to those listed above, industrial water supply, wildlife habitats and aesthetics are designated beneficial uses for all water bodies in Idaho.

The 2014 Idaho Integrated Report document was developed by the Idaho Department of Environmental Quality (IDEQ) and approved by the EPA in 2017. Boulder Creek, from the confluence with the east fork to the mouth is identified as category 4a waters, which indicate a TMDL has been completed. All other tributary streams in the project area are identified as fully supporting beneficial uses.

A total maximum daily load (TMDL) for temperature in Boulder Creek was approved by the EPA in 2014. From the confluence with the Kootenai River to Rummy Creek in the headwaters, the TMDL document identifies the streamside potential natural vegetation (PNV) that provides shade to the creek, and also identifies where shade may be lacking.

Stream Channel Characteristics

Streams in the project area were surveyed between 2013 and 2016 and included segments of the main stem of Boulder Creek, Middle Fork Boulder, East Fork Boulder and several tributaries such as North Creek and Cabin Creek. Stream surveys documented conditions of streams including characteristics such as channel stability, habitat conditions, fish presence, potential barriers, sediment sources, overstory canopy, quantity of large woody debris, along with other general observations and assessments.

There are over 120 miles of stream Channel in the Boulder Creek watershed. The headwater streams can be typically described as ‘A’ type channels which are steep (upwards of 12 percent), step-pool systems with gravel and cobble substrate with occasional boulders and frequent pieces of large woody debris (LWD). Finer material consisting of sands and small gravel were found in pools. “A” channels are characterized as entrenched, high energy debris transport systems which are resistant to disturbance when composed of boulder and cobble substrate (Rosgen 1996). Continuing downstream, the stream types shifted to lower gradient reaches with finer substrates in the main stems of in the Boulder Meadows area. These streams are more sinuous and had good access to their floodplains which often contained adjacent wetland complexes. The main Boulder stream channel below boulder meadows increases in gradient and is described as a ‘B’ channel type with large boulder substrate. Stream surveys documented good habitat with pools and copious amounts of LWD. The lowest several miles of Boulder Creek enters into the canyon stretch where it steepens again becomes bedrock controlled with numerous waterfalls, some of which are over 20 feet tall. The lowest of these waterfalls is a natural barrier to fish migration from the Kootenai River. Boulder Creek has a large alluvial fan at the confluence with the Kootenai River.

Upper Boulder Creek has a ‘low’ rating and Lower Boulder has a ‘moderate’ watershed condition rating based on the Idaho Panhandle National Forests (IPNF) watershed characterization spreadsheet. The watershed characterization exercise was completed to assess stream conditions at the 6th code hydrologic unit level, forest-wide in support of the 2015 Revised Forest Plan. This spreadsheet uses a metric composed of a variety of factors including watershed sensitivity, watershed disturbance and riparian disturbance. The moderate rating is likely a result of riparian disturbance and road densities from past management activities. The low rating for Upper Boulder indicates that it is functioning properly.

Existing Condition

Water Quality

Sediment Delivery

The table below displays the results from the FS WEPP Road modeling, showing the total sediment delivered to streams associated with selected road segments that were identified by field surveys to be contributing sediment to the stream network. Values are in average annual sediment delivered. Overall there are approximately 6700 feet of roads that are producing and delivering sediment to the creeks in the project area. Road 274 has the greatest sediment contribution of 2.2 tons/year due to the frequent tributary crossings coupled with greater maintenance needs. The majority of the sediment being delivered to creeks comes from roads open to public motorized use. This is expected as these roads see high motor vehicle use, have limited maintenance, and often times located in very close proximity to valley bottom creeks. The restricted motorized use roads have less wear and damage from traffic (i.e. rutting in the wheel tracks) and have a greater vegetative cover across the driving surface which reduces erosion. The sediment values presented in the table below do not include sediment delivery from road failures.

Table 2. FS WEPP Road results of sediment delivery to streams from road segments.

Road	Sediment Delivery (tons/year)	Total length of contributing segments (feet)
FSR 408	0.43	1810
FSR 427	0.69	1670
FSR 274	2.20	3220
Total	**3.32**	**6700**

FS Disturbed WEPP modeling was used to identify upland erosion being delivered to project area creeks. Representative project area hillslopes of units were used in the modeling. The results from the WEPP modeling showed no upland erosion delivering sediment to project area streams. It is therefore assumed that all current project area sediment delivery is due to road activities.

Water Temperature

GIS analysis indicates there are approximately 5,500 acres within Riparian Habitat Conservation Areas (RHCAs) within the Boulder Creek watershed. The vegetation within the RHCAs is primarily intact, providing the protective shade to the waterbodies. There are areas that have had timber harvest in the past and are recovering and have not fully reached their maximum shade providing potential. There are also areas where roads encroach on the RHCAs and have reduced shade for the width of the road. Figure B-16 in the 2014 Potential Natural Vegetation Temperature TMDL (IDEQ 2014) indicates that approximately half of the main stem of Boulder Creek is currently at reference condition for the expected amount of riparian vegetation. Other areas along the main stem show a shade deficit from potential conditions ranging from 20-65%. However, the majority of RHCAs within the project area are tributaries to Boulder Creek, and have not been analyzed or included in the Temperature TMDL. Most of the tributaries of Boulder Creek are within roadless areas with minimal amounts of disturbance and are therefore providing their full potential for shade.

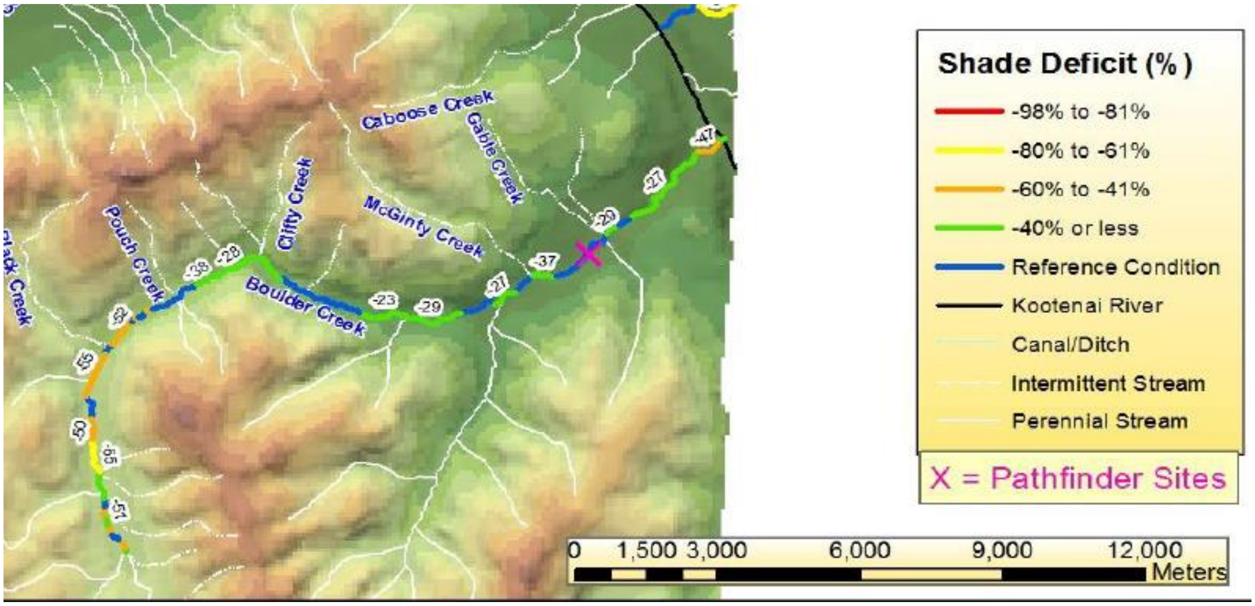

Figure 2. Excerpt from Temperature TMDL showing shade deficits for the main stem of Boulder Creek.

Watershed Function

Road Density

There are approximately 69 miles of roads exist in the 64 mi² Boulder Creek watershed. This includes open and restricted motorized routes. There are no motorized trails in the Boulder Creek watershed. Table 4 displays road densities for the project area, including road densities within RHCAs. There are approximately 11 miles of roads within the 8.6 mi² of RHCAs within the Project area. Roads within RHCAs have the highest probability of delivering sediment to streams. Road densities were calculated by dividing the total road miles by the area of the Boulder Creek watershed. Road densities within the riparian zones were calculated by dividing total road miles within the RHCA by the total area of the RHCAs. Field surveys identified several road segments that are persistent sources of sediment for project area streams.

Table 3. Road Densities.

Analysis Unit	Total Miles	Road Density (mi/mi²)	Total Miles in RHCAs	Road Density in RHCAs (mi/mi²)
Boulder Creek Watershed	69	1.1	11	1.3

Equivalent Clearcut Area

The baseline ECA value for Boulder Creek was obtained from the Watershed Characterization that was conducted for the IPNF Forest Plan revision in 2015. Background data of past harvest, fires, and road construction was used in the analysis. The current ECA value for the Boulder Creek watershed is 1845 acres, which is 4.5% of the watershed area.

Environmental Consequences

Alternative 1 – No Action

Under the no action alternative, none of the timber harvest operations, reforestation, road maintenance or reconstruction, temporary road construction or other project activities associated with the action alternatives would take place.

Direct and Indirect Effects to Water Quality

Sediment Delivery

Sediment contributions from roads would remain unchanged from the existing condition. Road maintenance would occur as normal and would be beneficial, but the normal intensity of maintenance may not provide the same degree of improvements as proposed with reconstruction, to reduce the risk of road failures. Therefore, the lack of road improvements commensurate with the current level of road conditions in the project area could perpetuate sediment delivery from surface erosion and increasing risk of culvert failures.

Delaying harvest in overstocked timber stands could result in an increase in tree mortality and fuel build-up. Continued fuel loading would increase the risk of high intensity wildfires that could kill most of the vegetation in both upland and riparian areas. Spigel and Robichaud (2007) reported maximum erosion rates exceeding 32 tons/acre after high intensity fire on steep slopes in west-central Montana, depending on fire intensity, terrain, and climate. Increased runoff combined with a lack of vegetative cover to protect soils following a fire would lead to increased peak stream flows, excessive sediment delivery and consequent adverse impacts to water quality and aquatic habitat. The risk of debris flows immediately after a fire increases as a result of soil impacts coupled with increased potential for surface runoff. Debris flows can be the most damaging in the short-term to stream networks by the quantity of sediment that can be delivered. Impacts to soil erosion from these disturbances typically last a few years before rapid revegetation covers the surface with protective plant litter (Elliot 2004, Ryan and Dwire 2012).

Water Temperature

Alternative 1 would not include timber harvest, fuel treatments or road decommissioning, storage or reconstruction; thus no new direct or indirect effects to project area floodplains would occur. Through natural recovery, plant vigor and composition in the riparian zones would be expected to increase and contribute more shade as these areas recover from past treatments. The rate of progression and anticipated temperature changes would be slow and vary in time depending on the existing condition of the watershed including soils, vegetation, continuing activities, and intensity of past activities.

Direct and Indirect Effects to Watershed Function

Road Density

Project area road densities would remain unchanged because no temporary roads would be constructed and no roads would be stored or decommissioned.

Equivalent Clearcut Area

Under the no action alternative, ECA would be the same as described for the existing condition and would decrease as past harvest units throughout the watersheds continue to recover. There would be no new management activities that would affect ECA. However, delaying harvest in overstocked timber stands could result in an increase in tree mortality and fuel build-up. Continued fuel loading would increase the risk of high intensity wildfires that could kill most of the vegetation in both upland and riparian areas, thus increasing the ECA. For example, over 27,000 acres burned in Boulder Creek in the historic fire year of 1910, which may have equated to an ECA of 68%.

Alternatives 2 (Proposed Action) and Alternative 3

A full description of Alternatives 2 and 3 are provided in the BCRP EA. All actions described in Alternative 2 are included in Alternative 3, except for the landscape burning in the roadless areas. Alternative 2 proposes approximately 7400 acres of landscape burning where alternative 3 only includes about 200 acres. The following discusses the effects common to both alternatives, with a separate section for additional effects associated with Alternative 2.

Project Design Features

The Forest Service has the statutory authority to regulate, permit, and enforce land use activities on its lands that affect water quality and is responsible for implementing nonpoint source pollution controls and meet Idaho Water Quality Standards. To comply with State Water Quality Standards, the Forest Service is required to apply water quality practices in State Forest Practices Regulations, where applicable, reasonable land, soil, and water conservation practices, or site-specific BMPs. These practices are designed with consideration of geology, land type, soil type, erosion hazard, climate, cumulative effects, and other factors in order to protect and maintain soil, water, and water-related beneficial uses, and to prevent or reduce nonpoint source pollution.

The Boulder Creek Restoration Project EA contains a full list of project design features to protect aquatic resources.

Estimated Effectiveness – High. The 2016 Idaho Interagency Forest Practices Water quality Audit (IDEQ 2016) describes how the erosion control measures observed in the state-wide audit are generally effective when properly installed and maintained. This audit also acknowledged the Forest Service had 97% compliance during the last 4-year audit cycle and averaged 99 percent compliance with BMP rules since 1996. The same audit also found slash mats were the most practical method for controlling erosion from skid trails, and road measures, such as gravelling, rocking ditches, installing rolling dips and waterbars were effective at reducing erosion. This is corroborated by the FS WEPP:Road erosion modeling results, the literature review of research on BMPs conducted by Edwards et al. 2016 and also by local monitoring.

Direct and Indirect Effects to Water Quality - Alternatives 2 and 3

Sediment Delivery

Effects to Sediment from Road Reconstruction and Maintenance

Both alternatives propose about 76 miles of road reconstruction and maintenance. This would consist of brushing, blading, gravel additions to the driving surface, and drainage improvements. Road reconstruction would typically add improvements beyond what occurs with regular maintenance. Both action alternatives propose to improve drainage by replacing, upgrading, or installing new culverts, and/or cleaning and armoring ditches where necessary. Please refer to design criteria section of this document for specifics. Several opportunities to reduce sediment delivery from roads in the project area were identified during road surveys. Alternatives 2 and 3 propose to recondition specific segments of FSR 274, 427 and 408, totaling about 1.3 miles. FS WEPP:Road modeling indicates a reduction in sediment delivery of 3.3 tons/year can be achieved from these segments by a combination of installing ditch relief culverts or drivable dips before each perennial tributary crossing and graveling the driving surface over the crossings. Installing ditch relief culverts before stream crossings disconnects the ditch from the stream and allows sediment to filter out across the forest floor. FS WEPP:Road considers traffic levels so predicted sediment delivery values reflect high traffic conditions, which would describe traffic levels associated with the timber harvest operation. Alternatives 2 and 3 also propose to upgrade the Middle Fork Boulder Creek stream crossing under FSR 627. The culverts passing Cabin and Black Creeks under FSR 427 would also be upgraded when funds to do so are secured. Increasing the size of culverts would reduce the risk of failure as a result of insufficient capacity and blockage. BMPs will be incorporated into all road work since they have been shown to be protective of water quality and beneficial uses (Seyedbagheri 1996, IDEQ 2016, Edwards et al. 2016).

Some road reconstruction and maintenance activities, such as blading and ditch clearing, can increase the susceptibility of erosion on the road and ditch surface for a short time (days to weeks) after the work by making fine particles more available to movement. This increase can be mitigated by employing BMPs such as timing road blading to when soil moisture conditions are appropriate, or applying water with a tanker truck while grading during the dry season. Other BMPs that would be effective reducing sediment delivery in the short term are seeding, and using a roller to compact the surface after blading. Regardless, the long term benefits of improving drainage and armoring road surfaces would outweigh any short term increases as a result of maintenance and reconstruction activities.

The primary haul route from the project area for timber harvest operation is FSR 314. FSR 314 is a paved road which would negate increased sediment delivery as a result of increased traffic from this project. Secondary haul routes are FSR 408 and about 4 miles of FSR 2662. Sediment delivery from increased traffic would not be expected on these routes due to limited proximity to streams coupled with the inclusion of road reconstruction and BMPs described above.

An existing gravel pit located off of FSR 627 would be utilized as an aggregate source for road reconditioning activities. No impacts to sediment delivery would be expected from this source because the pit and access road are located on suitable terrain and are well away from streams and waterbodies.

Effects to Sediment from Road Storage and Decommissioning

Both action alternatives propose to store approximately 13.4 miles of roads and to decommission 1 mile. The roads proposed for storage and decommissioning are listed in Table 4 below. The road segments were identified primarily for wildlife habitat reasons, though it would also benefit hydrologic resources. The roads proposed for storage were not modeled with FS WEPP because of their current heavily vegetated condition and lack of active erosion process documented during field reviews. Research conducted on the IPNF indicates that thick duff, vegetation, and moss layers found on brushed-in roads protects the surface from erosion (Foltz et al. 2009). Since active sediment contributions are low from these segments, benefit would primarily be realized in the form of reduced risk of sediment delivery from culvert failure due to insufficient capacity or blockage. Storage would remove high risk drainage structures and install additional drainage, such as waterbars and relief swales, to render the road stable and hydrologically inert. Stored roads should need no maintenance when in storage but remain on the FS inventory for possible future and emergency use. Culvert removals could be accomplished with machinery or by using explosives. There would be short-term increases in sediment and turbidity during removal of culverts. A 2007 study of culvert removals reports an average sediment delivery amount of about 150 pounds; however this amount can be reduced to about 4 pounds using appropriate BMPs (Foltz et al. 2007).

Both action alternatives propose to close approximately 3.4 miles of undetermined roads. These 'U' roads are on the road inventory but most are skid trails or fire lines that were added erroneously during aerial photo interpretation. Field review of the undetermined roads in the project area documented heavily vegetated, hydrologically inert conditions. Although sediment contributions are low, compacted driving surfaces left on the landscape can still increase runoff and disrupt hydrologic continuity. The same study by Foltz et al. (2009), also discloses that hydraulic conductivity of brushed-in roads does recover towards values found on undisturbed forest floors, but many decades of recovery may be needed. Field review of these roads indicates they are stable, heavily vegetated and lack ditches and drainage structures that are the primary cause of mass failures and disrupted watershed function. These roads would decommission themselves through natural revegetation since traffic has been excluded for several decades already, extensive vegetation is established, and the road designs are resistant to failures. Some U roads may be utilized during project implementation. If any U roads are used, they will have surfaces decompacted, waterbars installed, and will be seeded and/or covered with slash upon completion. This type of treatment will hasten recovery of the existing road prism.

Table 4. Roads proposed for Storage or Decommissioning.

Road Number	Prescription	Segment (milepost)	Total Length (miles)
2110	Storage	0.0-1.04	1.04
1304D	Storage	0.0-0.82	0.82
1304A	Storage	0.0-0.35	0.35
1304C	Storage	0.0-0.33	0.33
2662	Storage	5.8-6.7	0.90
2113A	Storage	0.0-3.00	3.00
628	Storage	4.0-6.50	2.50
628A	Storage	0.0-0.61	0.61
628C	Storage	0.0-0.82	0.82
1304G	Storage	0.0-1.59	1.59
1304H	Storage	0.0-0.43	0.43
1304	Storage	6.6-7.9	1.3
4801	Decommission	0.0-0.7	0.70
		Total	**11.85**

Effects to Sediment from Recreation Improvements

Recreation improvements would consist of improving trail and trailhead drainage, relocating problem trail segments and protecting non-motorized trails from unauthorized ATV use. An eroded segment of trail 136 would be rerouted to a more suitable location with lesser grades and away from streams which would reduce erosion potential. A segment of trail 180 may be rerouted if the adjacent gravel pit is expanded. The old segments of trail would then be closed and rehabilitated. These improvements would provide an overall improvement to hydrologic resources.

Effects to Sediment from Temporary Road Construction

Alternatives 2 and 3 would temporarily increase the risk of negative consequences of road/water interaction, such as culvert failures, with the construction of 3.2 miles of temporary roads. Although risk increases as a result of added mileage and road density, the consequences is expected to be minimal because of limited hydrologic connection to streams and length of time on the landscape. Further, some of the temporary roads are located on existing road prisms which are currently altering hydrology. The temporary roads are located outside of RHCAs and would be required to be recontoured when they are no longer needed for harvest activities.

Effects to Sediment from Vegetation Prescriptions

Disturbed WEPP Batch was used to estimate sediment delivery from proposed timber harvest and burning prescriptions for Alternatives 2 and 3. Modeling results indicate either action alternative would not increase sediment delivery over existing conditions. Units with proposed pre-commercial thinning prescriptions were not modeled because they would likely be completed by hand sawing and would have negligible ground disturbance. Also, if machinery such as a masticator were to be used, there would be minimal ground disturbance due to the copious amount of slash and plant material acting as ground cover. All modeling information can be found in the Hydrology section of the project file.

Timber harvest prescriptions include design features and BMPs to minimize soil disturbance. The BCRP EA (Appendix B) includes a detailed list of design features and BMPs such as timing restrictions to ensure project activities only occur when soils are not saturated. Potentially sensitive areas, including areas near known past mass failures, were excluded from units during project preparation and layout phase. Units that would be skyline logged create minimal ground disturbance. Ground skidding would be completed using measures such as slash mats and designated skid trail locations to reduce compaction. Since all timber harvest would include design features to protect soil and water, sediment delivery from these units would be so slight as to not be measurable. Research studies and monitoring results conducted on the IPNF verify that when riparian buffers are incorporated into timber sales, sediment delivery to stream channels is not measurable or is negligible. (IDEQ 2016).

Effects to Sediment from Landscape Burning

Alternative 2 proposes about 7400 acres of burn only units where alternative 3 proposes about 170 acres. A negligible increase in sediment yield to streams would be expected from the burn only units. The surface condition after a prescribed fire is typically a mosaic-like pattern of low severity, high severity, and unburned patches (Robichaud 2000). The patterns of burn severity help control the spatial scale at which the effects of prescribed burning can be detected (Troendle et al. 2010). The patchiness of burn severity allows unburned and low severity patches to infiltrate runoff and trap sediment that is generated on adjacent high severity patches (Biswell and Schultz 1957; Cooper 1961; Swift and others 1993). This project would include design criteria which excludes ignition within RHCAs. This would limit the fire severity and subsequent consumption of litter and surface roughness which traps sediment before it is delivered to the stream. Fire would be allowed to back into RHCAs but the intensity would be expected to diminish due to the increased shade, humidity, and fuel moistures found in riparian areas; and would be expected to have generally beneficial results. Dwire and Kauffman 2003 reported that prescribed fire may top kill certain riparian trees and shrubs but is unlikely to negatively affect belowground structure. This indicates the bank-stabilizing properties of the riparian vegetation is preserved and the trees, shrubs and forbs would recover quickly. The prescribed fires would have specific criteria to limit the severity of the fires included in the burn plans such as; constraints on fuel, duff, and soil moistures, weather conditions such as relative humidity, areas to exclude ignition, etc. Fire intensity would be further controlled and adjusted during implementation by modifying the patterns of ignition. Additionally, burns would likely be initiated a short time before wet weather is expected. The burn only units would be completed in parts over a time span as long as ten years, as favorable burning conditions occur.

Water Temperature

Direct incoming solar radiation is the dominant energy input for increasing stream temperatures with shade being the single most important variable to reduce this heat input (Cobb 1988, Gravelle and Link 2007, Krauskopf et.al. 2010). Of the proposed actions, timber harvest and to a lesser degree, landscape burning are the activities that could potentially increase the amount of solar radiation reaching the streams. Through the implementation of the INFS (USDA 1995) and the incorporation of RHCAs into the BCRP, the proposed activities would not further degrade water quality with respect to temperature because RHCAs would retain the canopy cover that prevents solar inputs to the stream.

This project proposes about 10 acres of timber harvest within riparian habitat conservation areas along the main Boulder Creek Channel. This proposed activity within the RHCA is not expected to be detrimental to stream temperatures because the natural topography and locations of the proposed units will protect streams and streamside resources and about 10 acres of timber harvest in over 5000 acres of RHCAs is a negligible percentage. The portions of unit 42 that encroach on the RHCA lie to the north of Boulder Creek and will maintain at least 150 feet of undisturbed vegetation between the unit and stream. Gravelle and Link (2007), found that the use of 75 foot riparian buffers effectively negated the effects of timber harvest (partial-cut and clearcut) impacts on stream temperatures in the reaches directly below harvested areas. This project will incorporate buffers that meet or exceed those described in the 2007 study. This unit would harvest a decadent stand of lodgepole pine to promote the regeneration of longer lived species such as white pine and larch, which would be beneficial to the riparian area when established. Special design features are included for this unit. Field reviews of project area streams documented dense, intact overstory and understory vegetation providing canopy cover.

The beaver reintroduction proposed by alternatives 2 and 3 would also have a benefit for stream temperatures. Beaver are an integral component of hydrologic, geomorphic, and biotic processes within North American stream systems, and their propensity to build dams alters stream and riparian structure and function to the benefit of many aquatic and terrestrial species. Recognizing this, beaver relocation efforts and/or application of structures designed to mimic the function of beaver dams are increasingly being utilized as effective and cost-efficient stream and riparian restoration approaches (Weber et al. 2017). This same study observed several benefits from beaver dams that may reduce temperature regimes, such as increased groundwater storage and release, and thermal refugia habitat for fish.

Through a partnership, Idaho Fish and Game would assess the habitat potential and reintroduce live beavers to the Boulder Meadows area of the watershed. In order to help establish a successful population of beavers, structures designed to mimic the function of beaver dams, called beaver dam analogs (BDAs) may also be constructed which would simultaneously provide some of the benefits of natural beaver dams.

Direct and Indirect Effects to Watershed Function - Alternatives 2 and 3

Road Density

Table 5 below illustrates that road densities would decrease with the implementation of either action alternative. The decrease is due to the proposed road storage of 11.1 miles and 1 mile of decommissioning for both action alternatives. This lower road density within RHCAs would help decrease the probability of modifying flows and decrease the likelihood of contributing sediment into stream networks. The proposed actions also include the construction of 3.2 miles of temporary roads, which would be stored after the timber harvests are complete. Temporary roads are not included in the road density calculations because of the limited amount of time they will be left on the landscape.

Table 5. Road density and Road densities within RHCAs by alternative upon project completion.

	Alternative 1	Alternatives 2 and 3
Motorized Roads (mi)	69	57.2
Project Area (mi^2)	64	64
Road Density (mi/ mi^2)	**1.1**	**0.9**
Roads within RHCAs (mi)	11	8.4
Area of RHCAs (mi^2)	8.6	8.6
Road density within RHCAs (mi/ mi^2)	**1.3**	**1.0**

Equivalent Clearcut Area

The ECA for the alternatives is presented in Table 8 below. Alternative 2 would raise ECA 9% to 5459 acres. Alternative 3 would raise ECA 7.5% to 4881 acres. The larger increase associated with alternative 2 is attributed to the proposed landscape burning.

Table 6. Equivalent Clearcut Area for Boulder Creek for all alternatives.

	Alternative 1	Alternative 2	Alternative 3
ECA (acres)	1845	5459	4881
ECA (% of watershed)	4.5	13.5	12.0
Increase in ECA from Existing Condition (% of watershed)	0	9	7.5

Increases in peak flow under either of the action alternatives would probably not be detectable in the main Boulder Creek channel and could not be differentiated from normal climatic fluctuations. Additionally, ECA values displayed in Table 8 represent conditions if all timber harvest and landscape burning activities occurred simultaneously in 2018. In practice, these activities would occur over a period of several years which would further reduce the ECA values. Grant et al. 2008 concluded from a comprehensive literature review that ECA under 20% will not have a detectible influence on water yield or peak flows that can be measured beyond natural variability. The above table shows that the watershed ECA's are indeed less than 20% of the watersheds, no further calculation or modeling of water yield or peak flow is warranted. The BCRP would have no detectible influence on water yield or peak flow.

The landscape burning would have a low impact to ECA for this project because the prescribed fires implemented would be a mosaic of severities with the majority being low to moderate intensity. Troendle et al. 2010 report that since low severity prescribed fires do not cause a high degree of tree mortality or litter combustion, the effects on evapotranspiration and forest floor water storage are generally too small to change watershed-scale water yields. This same publication summarizes numerous studies which confirm that light to moderate prescribed fire has little effect on streamflow.

Both action alternatives are within the historic range of variability when comparing the difference in the increase of ECA from the existing condition. During the 1910 fire, ECA may have climbed from zero to 68 percent, which according to Grant et al. (2008), would have increased peak flows. It is estimated that hydrologic recovery gradually occurs over 20-30 years. Hydrologic recovery occurs when conifer growth becomes mature enough to return transpiration, and canopy processes (snowfall interception, shade, etc.) to pre-disturbance values. Paired watershed studies suggest that any increase in annual water yields resulting from clearcutting will drop to zero within 30 years, and there may then be a period of a net decrease in water yields as a result of the active regrowth and changes in species composition (Jones and Post 2004). For the action alternatives, modeled water yield increases recover back to current levels by around 2050.

Changes in forest vegetation resulting from management or natural events can affect the frequency and magnitude of rain-on-snow events (Harr 1986). GIS analysis shows that about 39% of the cumulative effects area falls within the rain-on-snow zone. This is an elevation zone between 3000 and 4500 feet where the snow pack generally accumulates all winter long but is constantly near 0º Celsius. If a warm, moist air mass arrives and raises the freezing level above 4500 feet, rain falling on the snowpack below the freezing level can lead to rapid snowmelt and a large runoff event. The most recent rain on snow event that occurred in Boulder Creek was December 2015 where several roads in the project area were damaged, including where about 300' of FSR 314 was washed out. Floods are natural events and occur even when the watershed has a relatively low ECA. The greatest impacts observed from rain on snow events are not from the flood event itself, but occur when roads encroach floodplains or culverts become plugged from resulting floods and debris flows and cause damage to infrastructure such as roads. These events do not occur on an annual basis; and they are dependent on certain climatic conditions such as air temperature, intensity and duration of precipitation, rain-on-snow elevations, and snowpack characteristics (Berris and Harr 1987). In general, management-induced increases in peak flow (including peak flows from rain on snow events) diminish with the percentage of watershed impacted and increasing recurrence interval. Management effects on peak flow events over a 6 year recurrence interval are highly speculative (Grant et al. 2008). In summary, rain-on-snow and resulting peak flows are natural processes in the Cabinet Mountains and are responsible for the overall morphology and stability of stream channels in the area.

Cumulative Effects – Alternatives 2 and 3

Past, Present, and Reasonably Foreseeable Activities Relevant to Cumulative Effects Analysis

The following is a description of past, present and reasonably foreseeable actions that establish the appropriate geographic and temporal boundaries for the cumulative effects analysis. Activities identified below were considered relevant to the watershed cumulative effects analysis. Other activities listed in the BCRP EA (e.g. tree planting, firewood gathering, etc.) are not discussed here because there are no measureable soil or watershed disturbance anticipated by these activities.

Past Activities and Events

Wildfires, timber harvesting, homestead, and road construction activities have occurred throughout the watershed. More information on historic timber harvesting can be found in the vegetation section of the BCRP EA. These activities and their effects were analyzed using the ECA and FS WEPP models and incorporated into the current baseline condition, and to look at historic ranges of variability for the Boulder Creek watershed. This is discussed in the Affected Environment section of this document.

Substantial placer mining activities have occurred in the lower segment of Boulder Creek, located about 1.5 miles upstream of the confluence with the Kootenai River. Historical records and photos show how thousands of cubic yards of soil was washed off the hillside and sluiced down the Creek and likely explains the islands in the Kootenai River at the confluence. This area was examined by the project hydrologist in 2016.

Road storage has occurred in the Boulder Creek watershed. Over ten miles of road has been stored, some completed in the 1990s and the most recent road storage occurred in 2011, and include the following routes; 2624A, 2627, 2173, 2173A and 2112.

Present, Ongoing and Reasonably Foreseeable Activities

Fire suppression activities over the last century within the Boulder Creek drainage have allowed, and would continue to allow, untreated stands to progress toward climax vegetation conditions. The current trend is toward increasing stand densities, which makes them more susceptible to insects, disease and risk of fires (Vegetation and Fire and Fuels sections). Since changes in water yield are associated with vegetation conditions, the existing and future trends would have an effect on water yield.

General motor vehicle, off road vehicle, and snowmobile use on roads and trails. Motorcycles, ATVs and snowmobile use of the area may increase as motorized recreation popularity increases. Increased traffic and a lack of road or trail maintenance can cause an increase in erosion and sediment delivery.

Road and trail maintenance activities occur annually to some degree within the watershed. These activities include, but are not limited to, blading, brushing, and ditch/culvert cleaning. Maintenance typically improves drainage and decreases erosion from water channeling down the road surface. Culvert and ditch clearing lowers the risk of failures.

There are several active mining claims on the main Boulder Creek Channel.

About 300 feet of FSR 314 that was washed out by the December 2015 flood event will be reconstructed. The road will be relocated further from the stream channel to allow more floodplain access for Boulder Creek and reduced chance of road failure.

The Leonia project has approximately 500 acres of commercial thinning partially completed that lies within the Boulder Creek watershed. Activities for this project were analyzed under the Leonia EA. The Leonia project will also store several miles of road upon completion. Potential effects from this project are modeled with the ECA analysis.

The Northzone Roadside Salvage project has road segments located in the Boulder Creek watershed. This project proposes to remove hazard trees and blow down along selected open Forest Service roads. This project is not expected to cause additional effects to aquatic resources because of minimal increase of canopy openings, INFS criteria would be expected to be met, and no equipment would leave the road surface. There are no Northzone Roadside Salvage units currently planned within the Boulder Creek watershed.

Timber Stand Improvement – This activity (pruning, thinning, etc.) would occur outside RHCAs except where it could potentially improve riparian habitat. No ground disturbance would occur and timing restrictions would be enacted. No detrimental direct or indirect effects to watershed and fisheries are expected to occur.

Activities on private lands- There are only about 50 acres of private lands within the Boulder Creek watershed, comprised of patented mining claims. The private lands are away from streams and are a small enough component of the watershed to have negligible effects from activities that may occur on them.

Cumulative effects to Water Quality for Alternatives 2 and 3

Sediment Delivery

The combination of direct and indirect effects of all alternatives with past, present and reasonably foreseeable activities within the cumulative effects area would result in an overall net decrease in sediment yield to the Boulder Creek watershed upon project completion. As calculated, both alternatives would have the same net reduction in sediment of approximately 3.2 tons per year (average annual amounts). These reductions are realized primarily by the proposed road reconstruction. The road storage and decommissioning treatments would also reduce the risk of sediment delivery due to road failures but this amount is not included in the sediment modeling results. Alternative 1 would provide no sediment reductions since none of the identified road segments would be addressed.

The historical placer mining areas in lower Boulder Creek were visited by the project hydrologist in 2016. The hillslopes were over-steepened and topsoil was washed away by the placer mining activities which has slowed revegetation. The areas still have unstable slopes that are eroding, however, sediment contributions to Boulder Creek appear minimal because the revegetation that has occurred is on the toe of the slopes where it catches any sediment on the rough forest floor. See the hydrology project file for field notes on this area.

There are several active mining claims along the Boulder Creek Channel. These claims are primarily for recreational mining that are occasionally worked. They are limited by permit to hand tools and as such, are not expected to have a significant impact on channel processes, riparian vegetation or sediment delivery.

Within Boulder Creek, the ongoing activities and reasonably foreseeable projects, such as the Leonia project are not expected to increase sediment contributions to this watershed. Both projects would include the use of BMPs per the Idaho Forest Practices Act requirements. Sediment reductions would be realized with either action alternative proposed by this project. Regular road maintenance activities are expected to have a general beneficial effect toward aquatic resources through reduced sediment delivery and risk of road failures.

Water Temperature

The combination of direct and indirect effects of the action alternatives with past, present and reasonably foreseeable activities would preserve the shade-providing riparian vegetation within the 5000 acres of project area RHCAs. This would not further degrade water quality with respect to temperature because RHCAs would retain the canopy cover that prevents solar inputs to the stream. The riparian vegetation would continue to slowly improve as the stands grow and mature. The 10 acres of timber harvest proposed within the RHCAs would reduce canopy cover, though it wouldn't impact stream shade because the unit is oriented to the north of Boulder creek and 150 feet of undisturbed RHCA would be left between the unit and the stream.

Once established, the beaver reintroduction and possible construction of beaver dam analogs in the Boulder Meadows reach would be expected to have a positive benefit for water temperatures through increased surface water storage, increased groundwater to surface water exchange which may augment early summer baseflows (Baldwin 2015).

Cumulative Effects to Watershed Function for Alternatives 2 and 3

Road Density

Both action alternatives would reduce the overall road density in Boulder Creek as described in the direct effects section. The Leonia project will store an additional 2 miles of FSR 2111 which is located in the Boulder Creek watershed, upon completion of that project. That will further reduce road overall road densities in the Boulder Creek watershed from 1.1 to 0.86 mi / mi^2 and would reduce road densities within RHCAs from 1.3 to 0.88 mi / mi^2. The road storage and decommissioning proposed with BCRP would complement the road storage that has already been completed in the watershed. Lower road density overall and especially within RHCAs would help decrease the probability of modifying flows and decrease the likelihood of contributing sediment into stream networks.

Equivalent Clearcut Area

Cumulative effects for Equivalent Clearcut Area (ECA) take the direct effects of the harvests and road activities and combine them with the ECA that is resultant from all past vegetation management and road activities that have occurred in Boulder Creek watershed.

Table 7. Cumulative ECA in Boulder Creek under Alternative 2 and 3.

	Alternative 1	Alternative 2	Alternative 3
Existing ECA (acres) from past activities (timber, roads, fires)	1845	1845	1845
Proposed ECA from Timber harvest	0	3040	3040
Proposed ECA from Landscape burning	0	592	14
Cumulative ECA (acres)	**1845**	**5459**	**4881**
Cumulative ECA (% of watershed)	**4.5**	**13.5**	**12.0**

As discussed in the methodology section, Grant et al 2008, concluded from a comprehensive literature review that ECA under 20% will not have a detectible influence on water yield or peak flows that can be measured beyond natural variability. Since the BCRP considered with other activities occurring in the Boulder Creek watershed will increase ECA to 13.5% and 12% for alternatives 2 and 3 respectively, the BCRP would have no detectible influence on water yield or peak flow.

Summary of Environmental Effects

The effects of the proposed actions on water quality would include the reduction of sediment delivery to project area streams through the prescribed actions of reconstruction, decommissioning and storing project area roads and improving riparian area shading through natural recovery (decrease in water temperature) in the riparian areas. Water quality is expected to improve with both action alternatives in Boulder Creek with this project. There are no negative impacts to water quality associated with the proposed harvest and burn activities. Alternatives 2 and 3 would have a similar positive impact on water quality because they propose the same road treatments.

Watershed function would also improve in upon completion of this project. This improvement is seen in the reduction of road densities which reduces the number or road/stream interactions and altered hydrology. Strictly by the quantitative numbers, there is not much difference between Alternatives 2 and 3. Qualitatively, Alternative 2 has a greater benefit to Boulder Creek by treating more area with landscape burning. The BCRP Fire and Fuels report describes how large landscape-scale fuels treatment units have a better probability for decreased fire severity and disrupting large fire growth in the eventuality of a wildland fire. A large high-severity wildfire in Boulder Creek would have negative consequences to aquatic resources for decades. Both action alternatives are within acceptable ECA amounts, with harvesting and road activities not having a measureable impact on water yield and peak flows. Both action alternatives are also in compliance with the Forest Plan, the Clean Water Act, State Water Quality Laws, and all other pertinent regulatory framework.

Compliance with the Forest Plan and Other Relevant Laws, Regulations, Policies and Plans

Idaho Panhandle National Forests Plan

All alternatives meet the requirements of the IPNF Forest Plan for water resources and fisheries. The reduction in sediment delivery, reduced risk of road failures, improved aquatic organism passage in Boulder Creek and protection of RHCAs would all benefit aquatic resources. The hydrology project file contains information regarding compliance with specific forest plan goals, objectives, guidelines and standards.

Clean Water Act, Including State of Idaho Implementation

All alternatives would be consistent with the requirements of the Federal Water Pollution Control Act as amended by the Clean Water Act, 33 U.S.C. §1251. Water temperature would not increase in the listed segments of Boulder Creek as a result of implementation of any alternative or any of the foreseeable actions. The areas along Boulder Creek that are identified as shade deficit segments in the TMDL will continue to grow and mature thus providing additional shade over time. Through implementation of INFS, BMPs and the net sediment reduction that would take place, risks to beneficial uses designation for support of cold water biota, primary contact recreation and salmonid spawning in Boulder Creek and tributaries would be reduced by implementation of either of the action alternatives.

Idaho Forest Practices Act

Best Management Practices or soil and water conservation practices would be applied under all action alternatives, and all activities comply with the guidelines in the soil and water conservation handbook. A recent audit of BMPs pertaining to water quality indicates the USFS averaged 99% compliance with BMP rules since 1996, and identifies that BMPs are effective when properly installed (IDEQ 2016).

Idaho Stream Channel Protection Act

All alternatives would be consistent with the requirements of this act. INFS criteria incorporates specific protections for stream channels, and is included in this project.

Executive Orders 11988 and 11990

All alternatives are consistent with these EO's regarding floodplains and wetlands. This project proposes no development within wetlands or floodplains. Further, INFS criteria incorporates specific protections for these areas, and is included in this project.

Other Agencies and Individuals Consulted

- Kootenai River Watershed Advisory Group (WAG)

The Kootenai WAG is also a subcommittee of the Kootenai Valley Resource Initiative, which is the collaborative group that helped develop the BCRP. This group provided input on historical and current watershed activities and helped shape the project.

- Idaho Department of Environmental Quality – Bob Steed and Craig Nelson.

Bob and Craig provided clarification on water quality issues and beneficial uses.

- Idaho Department of Fish and Game – Brian Johnson

Provided information regarding beaver reintroduction logistics.

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